Bay Area Air Traffic Challenges Today

- **Traffic is rebounding and will exceed 2000 levels**
- **Aircraft delays are returning**
- **Major capacity improvements involving new runways or other large capital programs are difficult due to cost and environmental hurdles**
- **What can technology do to enhance capacity, reduce delays, and improve safety?**

What's the Question?

- **What are benefits to individual approaches/departures?**
  - **Savings in flight time fuel burn?**
  - **Reduced landing minimums?**
- **What are benefits to multiple approaches/departures at same airport?**
  - **More simultaneous independent operations?**
  - **Increased capacity and reduced delays?**
- **What are benefits to regional air traffic and ATC?**
  - **Reduced pilot and controller workload?**
  - **Greater utilization of secondary airports?**
- **In short: "What do these advanced navigation systems, singly or in combination, enable us to do?"**

Technology Objectives

These technologies are potential tools for airport system planning to help achieve the objectives of:

- **Providing all-weather landing capability at multiple airports**
- **Providing conflict free transition routes to and from regional airports**
- **Enhancing regional airport system capacity through coupled performance-based surveillance and communications systems**
- **Maintaining visual arrival and departure rates in low-visibility conditions**

What Are the Technology Enablers?

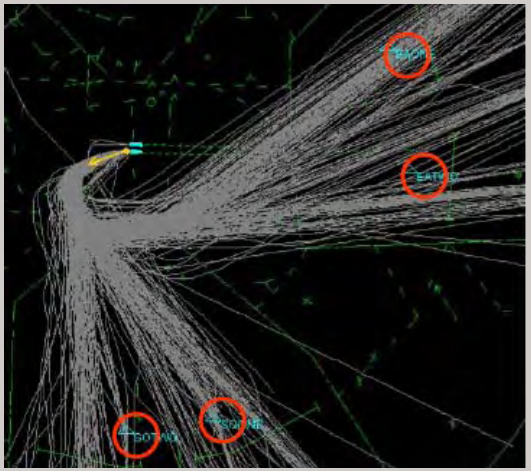
- **Location accuracy**
- **Pilot and controller vision**
- **Spacing and sequencing**
- **Workload reduction**

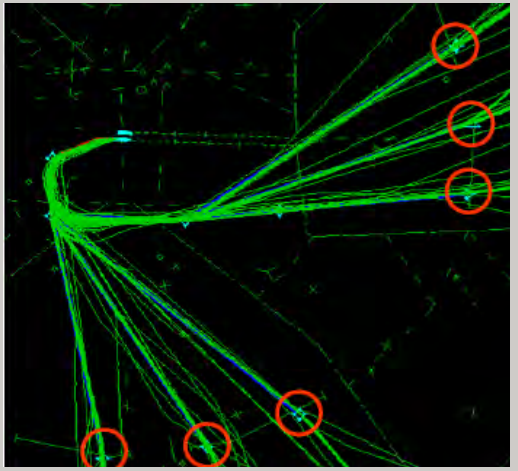
Location Accuracy

- **Do you know where you are and where everyone else is?**
  - **Area Navigation (RNAV)**
  - **Required Navigation Performance (RNP)**
  - **RNP Special Aircraft and Aircrew Authorization (SAAAR)**
  - **Automatic Dependent Surveillance-Broadcast (ADS-B) with Cockpit Display of Traffic Information (CDTI)**

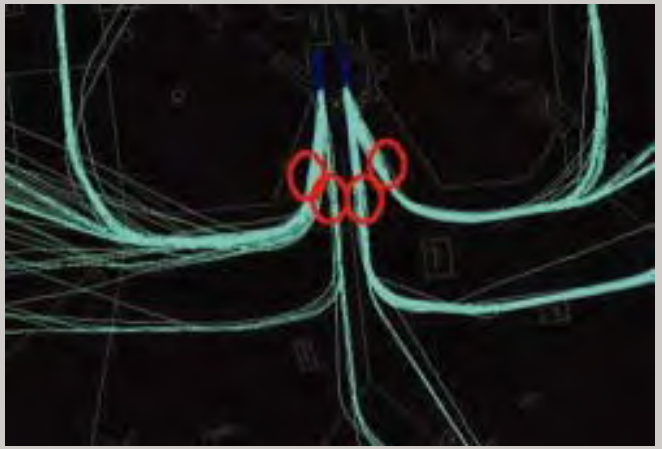
Radar Flight Tracks Before & After RNAV SIDS

- **ATL RNAV Standard Instrument Departures**





- **DFW (AAL) RNAV Standard Instrument Departures**



Source: RNAV/RNP Program Update, Federal Aviation Administration

Departure Procedures- Before & After RNAV

BEFORE

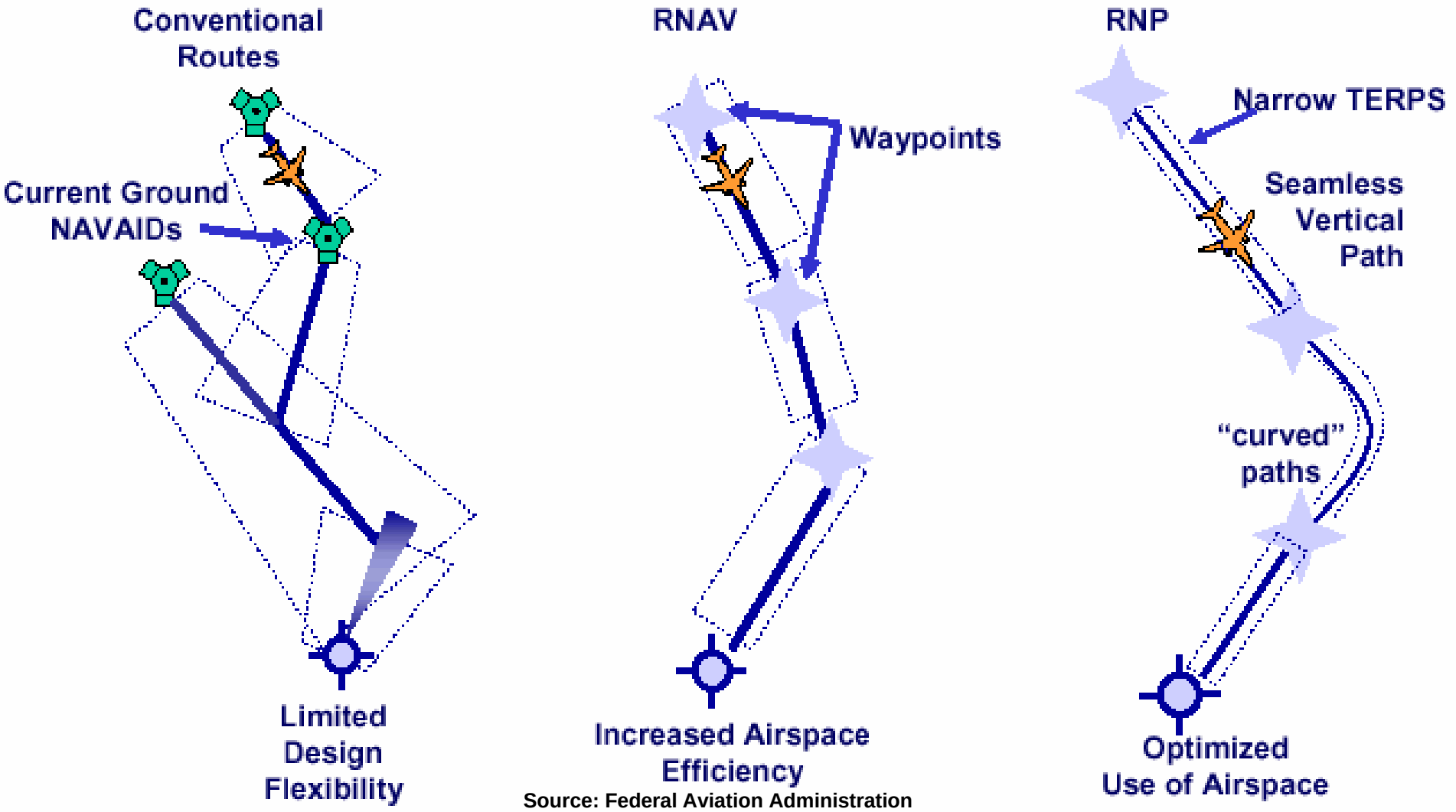
- **Departures are vectored**
- **Significant dispersion**
- **Limited exit points**

AFTER

- **Departures fly RNAV tracks (not vectored)**
- **Flight-track dispersions reduced**
- **More efficient vertical profiles**
- **Additional exit points available**
- **Voice transmissions reduced (30-50%)**

Source: Federal Aviation Administration

Moving to Performance-Based Navigation

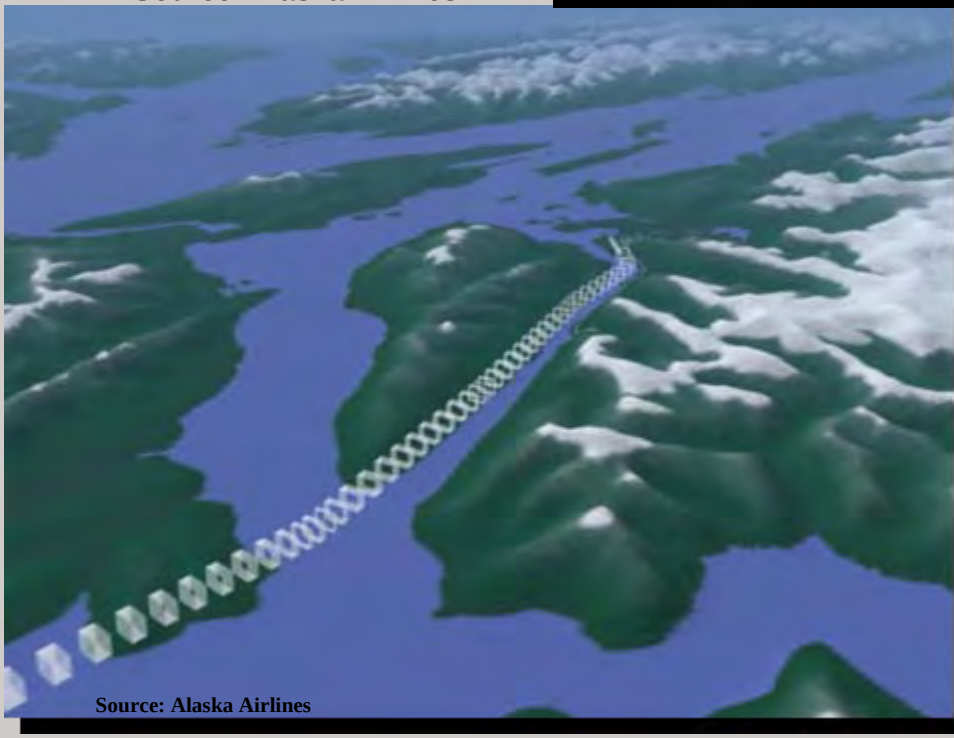


Source: Federal Aviation Administration

RNP Background – Alaska Airlines

- **Pioneered RNP in Alaska**
  - **To serve "terrain-challenged" airports (e.g., Juneau-Gastineau Channel)**
  - **Exploit advanced avionics on its B-737-400+'s**

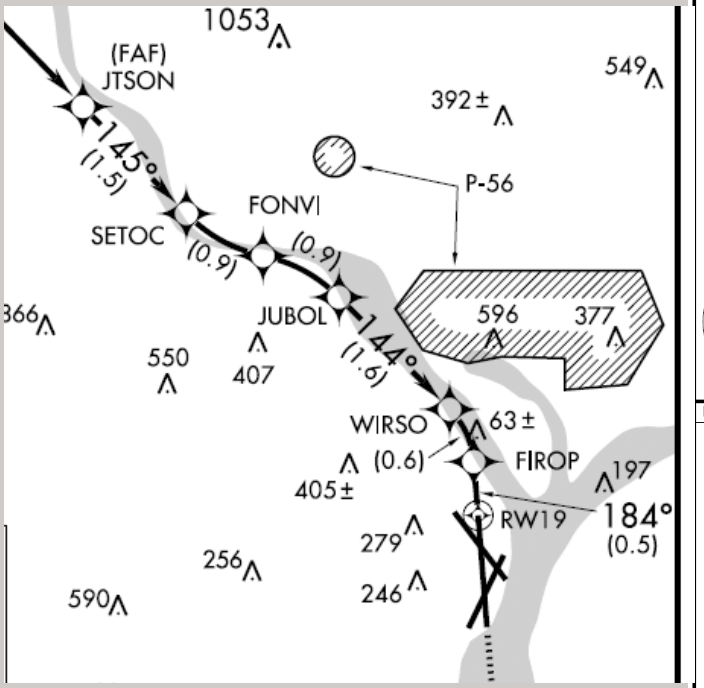
Source: Alaska Airlines



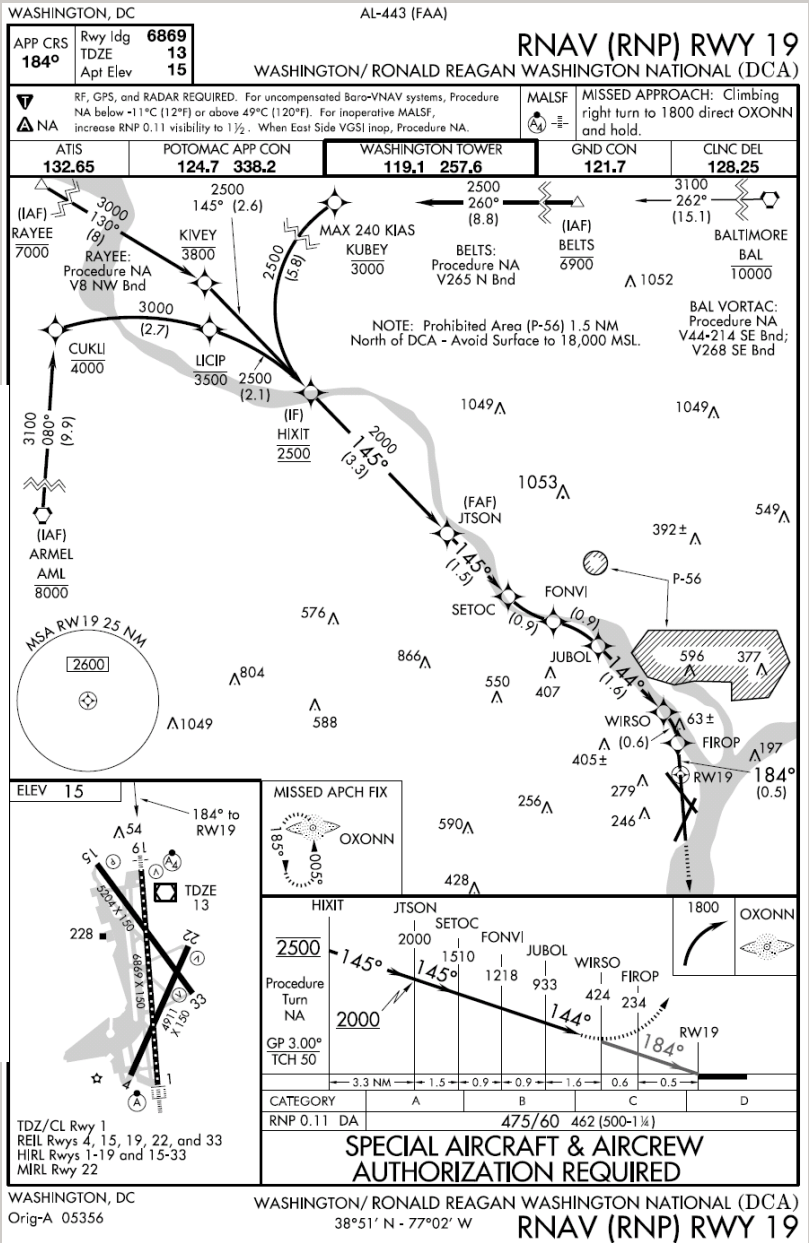
Source: Alaska Airlines

First Certified Public RNP SAAAR Approach to Runway 19 at DCA

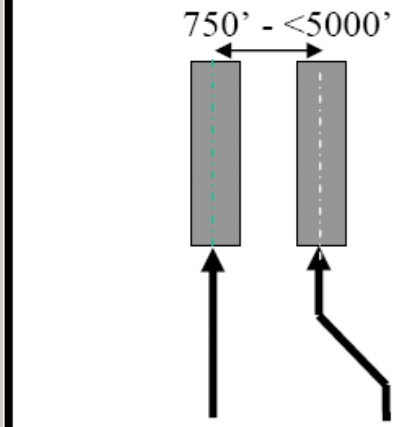
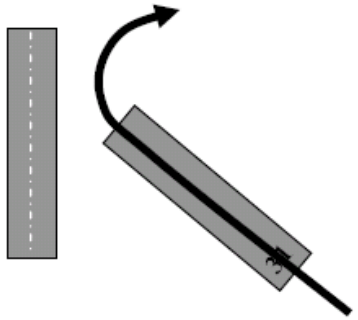
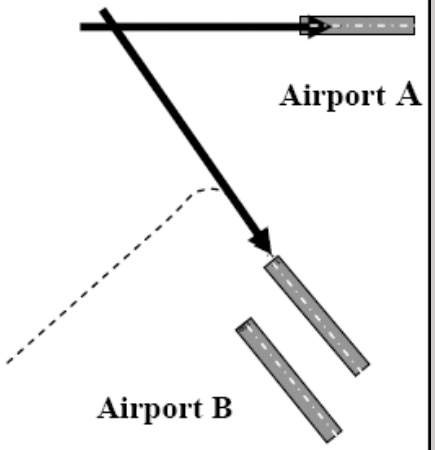
- **Established 9/28/05, RNP 0.11**
- **Previous approach minimums: 720-foot decision altitude and 2 & 1/4 mi. visibility**
- **RNP approach minimums: 475-foot decision altitude and 1 & 1/4 mi. visibility**



Source: RNAV/RNP Program Update, Federal Aviation Administration



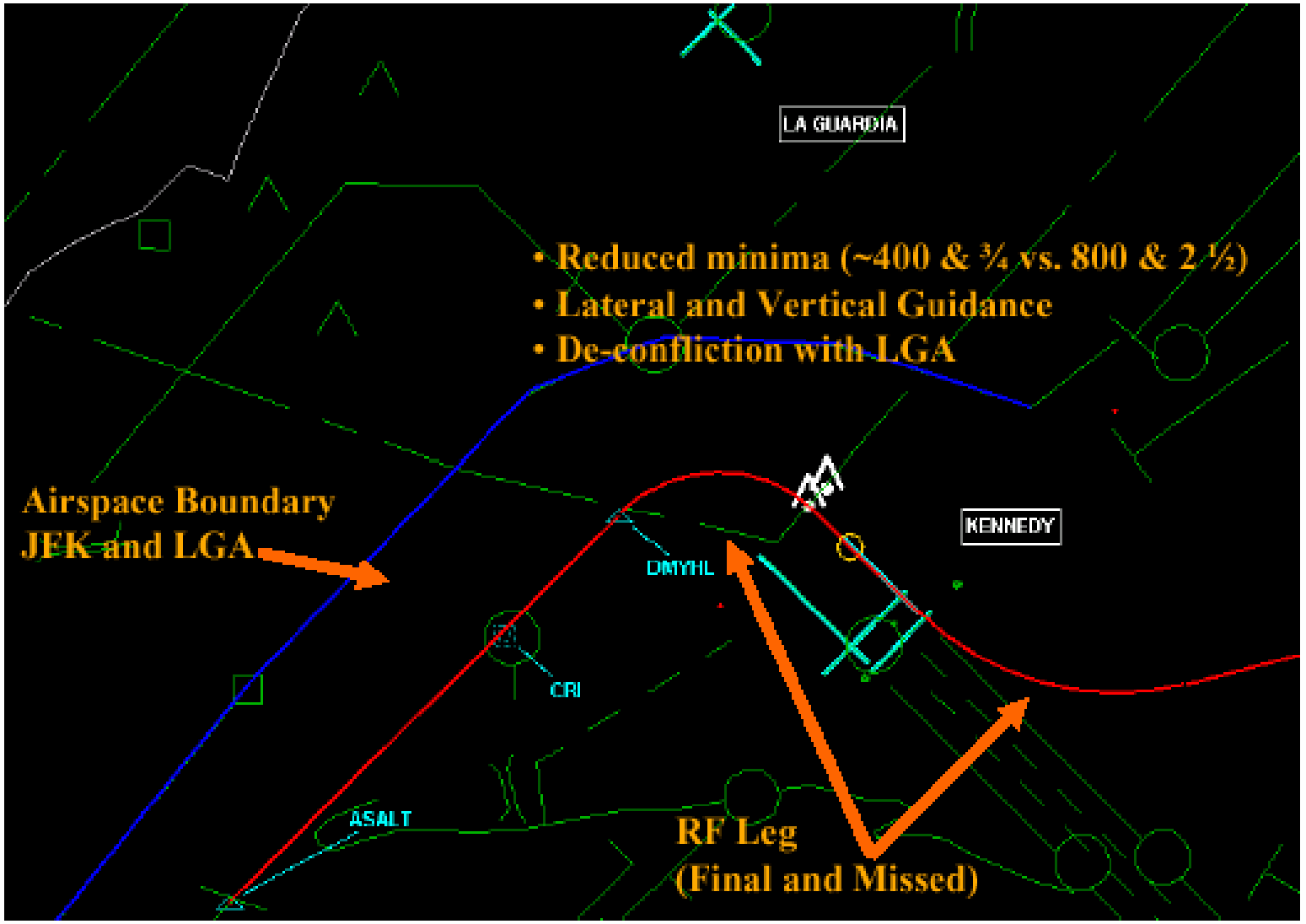
Applications of RNP SAAAR Criteria in U.S.

Parallel Operations	Converging Operations	Adjacent Airport Operations
		
10 to 15 Top Airports	15 to 20 Top Airports	10 to 15 Top Airports
Arrival capacity gains up to 60% over single runway operations	Arrival capacity gains up to 50% over single runway operations	Increased arrival and departure rates for adjacent airports involved

Source: Federal Aviation Administration

ILS Approaches to JFK Runway 13L and ILS Approaches to LGA Runways 4 and 22

Planned RNP SAAAR Approach to JFK Runway 13L/R Sponsored by JetBlue Airways



Source: Federal Aviation Administration

Automatic Dependent Surveillance-Broadcast (ADS-B) and Cockpit Display of Traffic Information (CDTI)

- **GPS-equipped airplanes constantly broadcast their current position and flight information over a dedicated radio datalink**
- **ADS-B “out" is envisioned by FAA as replacement of older, less-accurate radar systems**
- **ADS-B “in“ -- transmissions are received by**
  - **Air traffic control surveillance stations**
  - **Other ADS-B equipped aircraft within reception range that can display traffic on CDTI**

CDTI Support for Displaying Surrounding Traffic

Pilot Vision

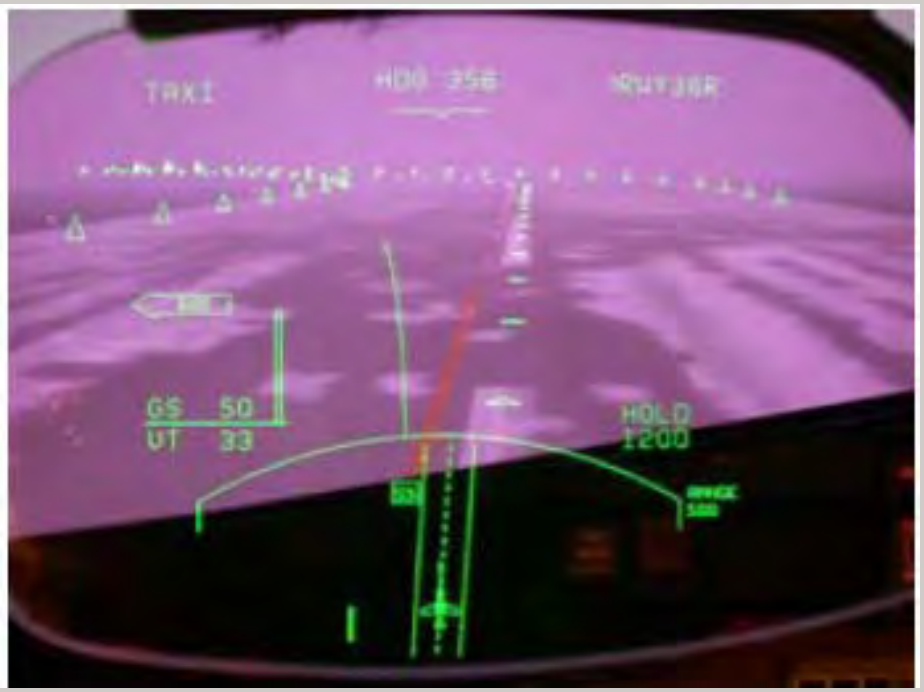
- **Can you see the runway environment and other traffic?**
  - **Head-Up Displays (HUD)**
  - **Head-Up Guidance Systems (HGS)**
  - **Enhanced Vision Systems (EVS)**
  - **Synthetic Vision Systems (SVS)**

Head-up Displays (HUD) / Head-up Guidance System (HGS)

- **Presents primary flight, navigation, and guidance information onto a transparent glass display positioned between the pilot's eye and the flight deck window**
  - **Focused at infinity**
  - **Provides for better situational awareness**
- **Show critical information**
  - **Airspeed**
  - **Altitude**
  - **Flight path**
  - **Runway image superimposed over actual view out window**
- **Southwest Airlines uses HUD alone to hand-fly Cat-III approaches**
- **Designating the HUD as the primary flight display is also under consideration**

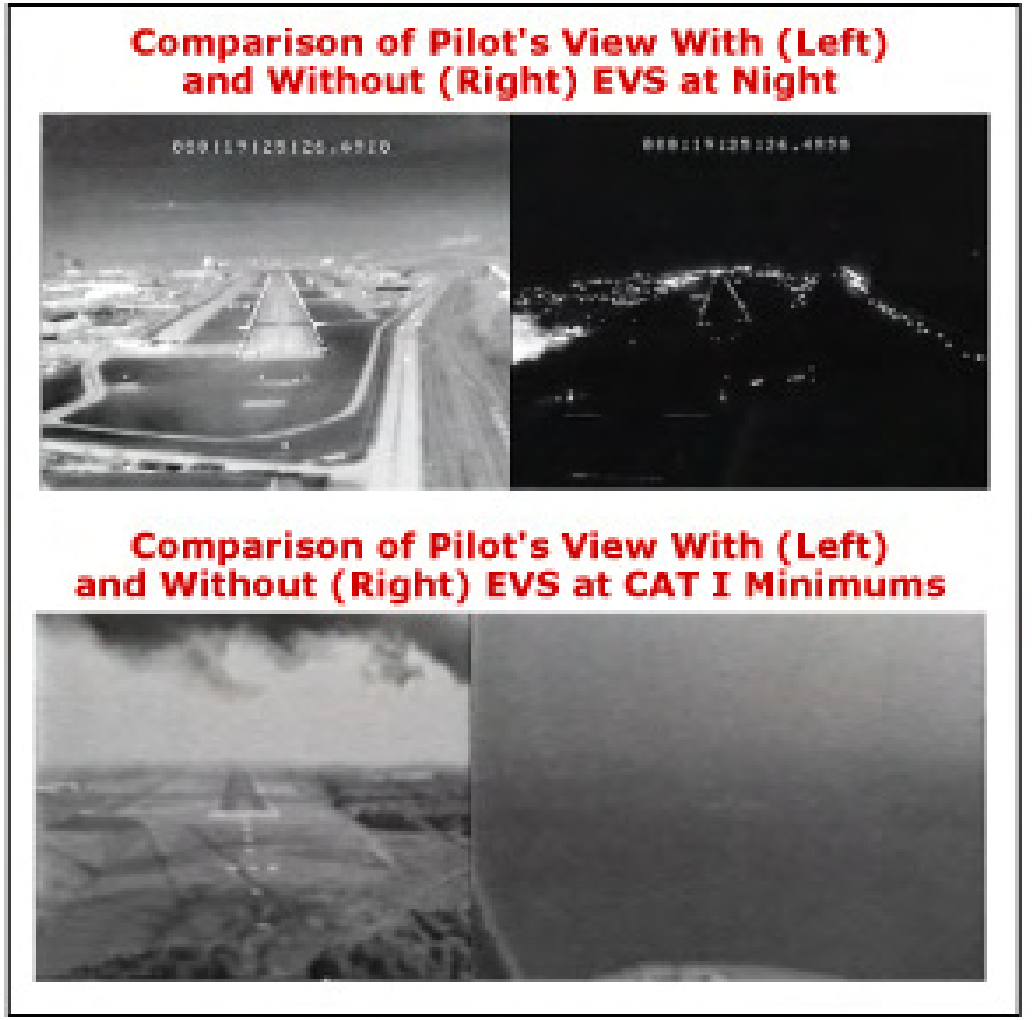
HUD / HGS for Surface Movements

- **Enables aircraft to takeoff in visibility conditions as low as 300 feet; normal visibility minimums are 600 feet**



Enhanced Vision System (SVS) Displays

- **Can display image of the airport environment, (buildings, ground vehicles, lighted and unlighted aircraft, and terrain, etc.) on head-up or a head-down display, such as a CRT or LCD**
- **Reportedly adds some $500,000 to price of HUD**



Enhanced Vision System (EVS) Displays

Enables Gulfstream 550 to fly CAT-I approach down to a decision height of 100 feet

Synthetic Vision System Displays

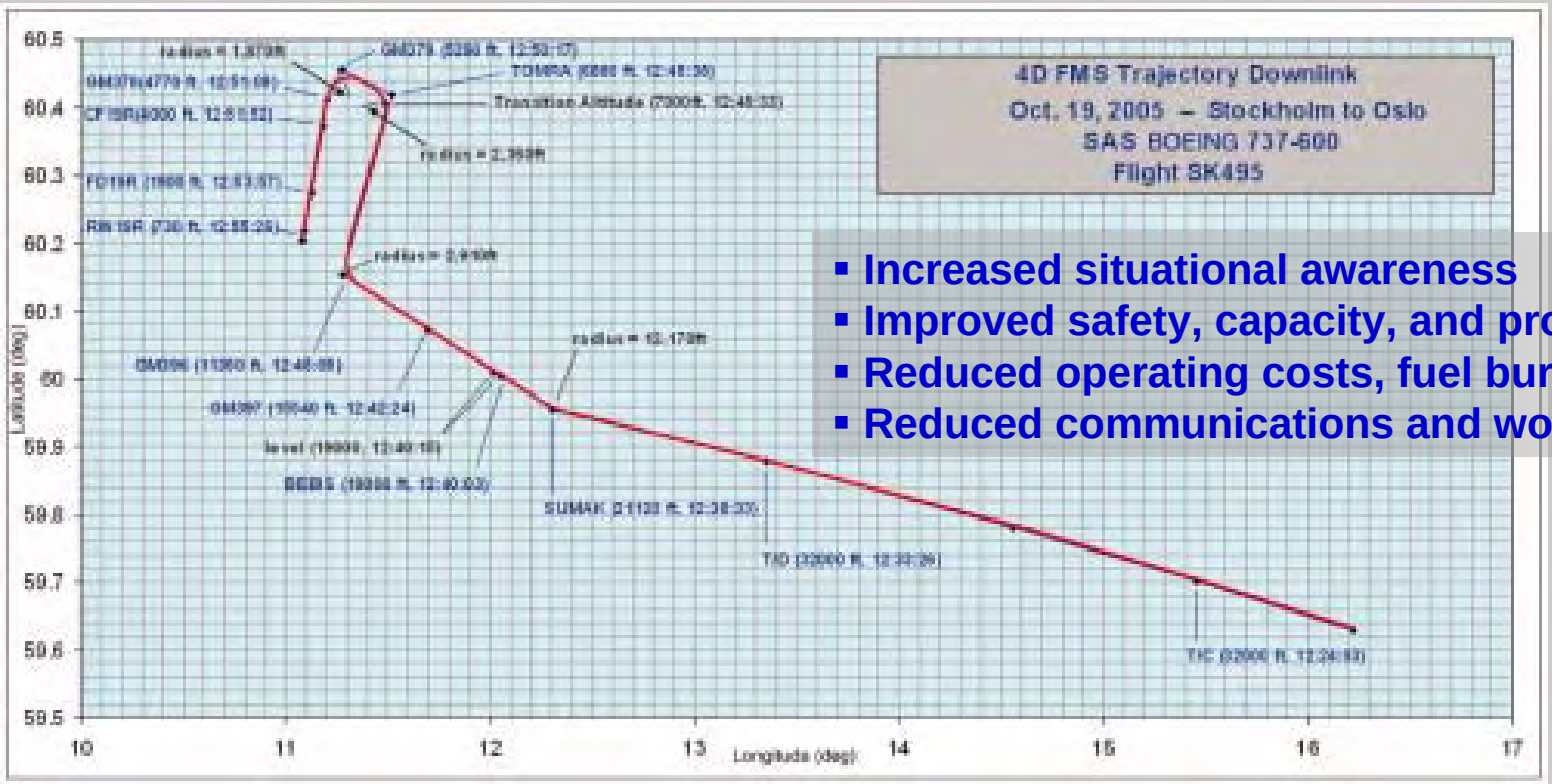
- **Provides pilots with a realistic depiction of terrain databases and standard aircraft systems on a standard flight deck display.**
- **SVS is primarily used on approach or takeoff during low visibility conditions, providing pilots with realistic visuals and easy-to-follow flight path guidance.**

Spacing and Sequencing

- **Can you maintain required aircraft spacing and sequencing of aircraft to optimize capacity?**
  - **4D Trajectories (4DT)**
  - **Controller Sequencing Aids**
  - **Autoland / Fight Management System**
  - **Downlink**
  - **4DT-based ATM Ground Station**
  - **Wake Turbulence Avoidance**
    - “Bubble”
    - Detection technologies
    - Airport design – using crosswinds

Swedish Flight Trials of 4D Trajectories

- **SAS B-737-600 FMS updated for downlinking "4D" trajectories to the runway up to an hour in advance**
- **Will enable controllers to establish a required time of arrival (RTA)**
- **Will allow pilots to:**
  - **Cross threshold within ±10 sec. of RTA**
  - **Conduct continuous-descent approaches (CDA)**
- **First "green approach" flown into Stockholm's Arlanda Airport on January 19, 2006**
  - **Constant descent at idle power from cruise starting at 34,000 feet 22 minutes out**



Source: Aviation Week & Space Technology 11/07/2005, page 50

- **Increased situational awareness**
- **Improved safety, capacity, and productivity**
- **Reduced operating costs, fuel burn, and emissions**
- **Reduced communications and workload**

It Comes Down to Industry Acceptance

- **Acceptance / comfort with technology**
- **Willingness to monitor rather than active control**
- **Pilot and controller acceptance**
- **NATCA / ALPA / Other acceptance**
- **Retraining and recurrent training**
- **Risk / blunder analysis**
- **Equipage – both aircraft and Air Traffic Control**
- **Mixed equipage**
- **Required performance vs. specific equipment**
- **System integration**